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THESIS

THE NAVY'S MODEL FOR ASSESSING LEASE VERSUS BUT DECISIONS IN SATELLITE COMMUNICATIONS SYSTEMS: AN EVALUATION

by

Joy L. Phillips

June 1985

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model fails to compare the same system output when comparing the two financing mechanisms. The analysis of the leasing alternative is based on the presumption that a leasing instrument will fix all inputs at the time of contract negotiation while the buy analysis presumes all inputs will remain variable. Last, the model inadequately addresses issues such as survivability and interoperability and how, or if, these elements of the MILSATCOM systems decision problem affect the lease/buy decision.

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The Navy's Model for Assessing Lease versus Buy Decisions in Satellite Communications Systems: An Evaluation

by

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Lieutenant Commander, United States Navy
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requirements for the degree of

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June 1985

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This thesis contains a policy analysis of the Navy's lease versus buy decision model used in the Military Satellite Communications (MILSATCOM) systems acquisition process. The general issues of the lease/buy question are considered as well as the specific quantitative methodology used in the Navy's current model. The model is found to be deficient in several ways. First, its basic assumption that public sector leasing can be less costly than buying is unfounded when total costs of the lease option to the whole economy are the criteria for comparison. Second, the model fails to compare the same system output when comparing the two financing mechanisms. The analysis of the leasing alternative is based on the presumption that a leasing instrument will fix all inputs at the time of contract negotiation while the buy analysis presumes all inputs will remain variable. Last, the model inadequately addresses issues such as survivability and interoperability and how, or if, these elements of the MILSATCOM systems decision problem affect the lease/buy decision.

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I. INTRODUCTION

To lease or to buy--an important yet enigmatic question when applied to today's military satellite communications (MILSATCOM) systems. The importance of the question and the issues concerning it center around the growing dependence of the Department of Defense (DOD) on sophisticated, space-based telecommunications systems for peacetime, tactical and strategic communications. Coupled with the increasing reliance on space-based systems is the magnitude of cost of such systems. Within the current decade, MILSATCOM costs will exceed $10 billion [Ref. 1: p. 26]. Because of increasing dependence on and cost of these systems, the DOD has sought the most cost effective means of acquisition. The lease versus buy question is part of this move toward cost efficiency.

To address lease/buy decisions adequately, the United States Navy has adopted a decision model to facilitate the evaluation and decision process as it pertains to the acquisition of satellite communications capabilities [Ref. 2]. That model is the subject of this thesis.

A. OBJECTIVES

The underlying purpose of this thesis is to analyze the Navy's present lease versus buy methodology as it pertains to space-based communications systems capacity and capability. The analysis is intended to be comprehensive and will address all relevant factors in the lease/buy decision of MILSATCOM.

First, what are thought to be the customary advantages and disadvantages of leasing? Of buying? In the civilian

marketplace, long-term capital leasing has been on the upswing since the late 1960's. What accounts for this phenomenon? Do the same economic forces play for the Federal Government in its evaluation of lease/buy options? If not, what circumstances are different and how should they shape the Navy's lease/buy decisions? These factors are essential to a comprehensive understanding of lease versus buy options for MILSATCOM.

Second, regarding the decision model presently used by the Navy in its lease versus buy evaluations, what are its strengths and weaknesses? What aspects of the decision, if any, are inadequately addressed in the model? Can the model be altered to expand its effectiveness in addressing all relevant factors in the decision? Such questions must be thoroughly addressed before any policy analysis is complete.

Third, there are factors in a MILSATCOM lease/buy decision which tend to be unquantifiable due to uniquely military requirements of the systems and due to public versus private sector acquisition. Because increasing national security is the ultimate objective of any military program, a simple dollar and cents comparison of alternatives often falls short in addressing the qualitative factors. Any decision model must include an evaluation of the unquantifiable as well as the quantifiable facets impacting the lease versus buy decision. A major portion of this thesis will be devoted to the analysis of the unquantifiables and how they affect the approach to and method of the lease versus buy evaluation.

Last, if the analysis is extended to focus not only on the Navy's objectives but also the objectives of the entire DOD and beyond even that level to include the entirety of the Federal Government, does the analysis take on different dimensions? Do the decisions and results remain the same? Ultimately, the question to be addressed is what is the best

method in securing the greatest amount of national security for the dollars spent on space-based telecommunications systems. Is this basic question thoroughly considered in the Navy's lease versus buy decisions? Are all underlying biases and assumptions made clear during the decision process? Herein lie the crux and thrust of this thesis.

B. ORGANIZATION

This study is organized into chapters, each with a specific purpose and set of questions entertained.

Chapter II provides the foundations for the entire thesis by defining basic terms of the lease/buy discussion. It also addresses private versus public sector leasing and how DOD leasing of MILSATCOM systems has been applied in the past. Congressional interest in MILSATCOM acquisition is also considered.

Chapter III introduces the standard arguments for and against leasing; for and against buying. The chapter discusses three broad areas for consideration in any lease/buy assessment: technical performance impact, management impact and financial implications. The basic attractiveness of leasing to Federal agencies is described and considered, as well.

Chapter IV analyzes the specific model presently used by the Navy in assessing lease versus buy decisions for MILSATCOM. In so doing, a general lease/buy model is formulated in accordance with General Accounting Office's procedures and guidelines. The Navy's model is then evaluated using this general model as a performance measure. Specific quantitative formulae of the model are addressed in general terms only.

Chapter V discusses elements of the lease/buy decision which are either not addressed in the Navy's model or are

underrepresented in the model. These shortcomings fall into three categories:

1. Faulty underlying assumptions on which the model is based;
2. Important considerations in the MILSATCOM system decision problem which are not adequately addressed in the Navy's decision model; and
3. The comparison the model makes is deceptive in that it does not compare the two financing mechanisms in the acquisition of the same MILSATCOM system.

The presence of faulty assumptions at the foundation of the Navy's lease/buy model calls into question the validity of leasing as a cost effective means of acquiring satellite communications capacity and capability. Also, the model fails to address such unique MILSATCOM system requirements as survivability and interoperability. In addition, the model fails to formulate the lease/buy analysis based on the same system being acquired by the two financing options. These concepts are dealt with extensively in Chapter V.

Chapter VI deals with recommendations and conclusions to the foregoing policy analysis. Recommendations deal not only with the Navy's posture on the lease/buy question but also the posture of the Federal Government in its entirety and the American society as a whole.

Although the opinions expressed herein do not reflect nor represent those of the United States Navy nor the Department of Defense, they are set forth in the hope and with the intention to provoke thought and stimulate discussion of the issues surrounding the MILSATCOM lease/buy decision.

II. SETTING THE BACKGROUND TO THE LEASE VERSUS BUY QUESTION

In order to formulate and understand the basic issues surrounding the lease versus buy decision, a foundation of information is required. First, basic terms must be reviewed to ensure the central issues of the lease/buy question will be addressed with a common background of clarity and understanding. Second, the emergence and evolution of leasing as a means of acquiring services must be considered. Last, the application of leasing in the public sector and in particular to MILSATCOM systems will be addressed.

A. DEFINITION OF TERMS

To begin, a few terms must be defined. What is a lease? And, what is a buy? Both terms seem quite familiar and to present no ambiguity. However, this is simply not the case.

1. To Buy

"To buy" means "to obtain in exchange for money or its equivalent: to purchase" [Ref. 3]. But procurement within the Federal Government carries with it many more stipulations and facets beyond just the exchange of money for the ownership of some property. To procure or buy a MILSATCOM system, for instance, the executive service[1] for the system must first state the requirement for the system and then justify its need within the DOD. Next, the inclusion of the system in the DOD Budget must be ensured, and, last, justification of the requirement for the system

---

[1]"Executive service" refers to the military service which is designated by the Office of the Secretary of Defense as the leader among the services in the project acquisition and management of a particular system to be used by more than one of the military services.

outside DOD, i.e. to both Houses of Congress, must be given. Once Congressional support has been obtained, no small feat in and of itself, funds must be appropriated and then authorized by both Houses, a process rife with pitfalls for even the most urgent of military programs. Once beyond the funding hurdle, a contract for the design, development and production of the system must be negotiated and administered through each phase of the program ultimately to its deployment and operation. The process is a long and tedious one, and at no point along the way is the system's future assured. Only once the system is in-orbit and fully operational is the "buy" a sure thing.

2. To Lease

"Lease" is another term which seems quite simple in its meaning, "to contract, granting occupancy or use of property during a certain period in exchange for a specified rent" [Ref. 3]. A lease is really a form of contract which stipulates the conditions of ownership and use of a particular property. In the case of MILSATCOM systems, the "property" is either the use of services or equipment in the satellite system. Such a contract defines the leasing party as a lessee and the other, or owning party, as the lessor. It is the lessee who receives the right to use the subject property in a lease, and it is the lessor who usually retains ownership of the property. A contractual lease specifies a period of time in which the lease is operative and stipulates an amount of money periodically paid by the lessee to the lessor for the use of the property.

The Internal Revenue Service (IRS) is much more precise in its definition of lease, however. The IRS recognizes two types of leases: the true lease and the conditional sale or pseudo lease. To be considered a true lease for tax purposes, the property owner must have title to the

property and have no guaranteed end-of-lease purchase price on the property. In other words, to be eligible for the tax benefits of ownership, the lessor must assume and retain full risks of ownership. Furthermore, the initial lease cannot run for 100 percent of the asset's economic life or else the lease is considered by the IRS to be a defacto purchase. [Ref. 4] The classification as a true lease results in the major financial benefit attributed to leasing, that of tax benefits accruing to the lessor who in turn, passes on these savings to the lessee in the form of lower leasing rates [Ref. 5: p. 2]. Generally, the IRS will classify a lease as a true lease if it provides that the property or equipment to be leased will have at least one year of its life expectancy remaining at the end of the lease; if the lessor assumes for financial-reporting purposes that it will have a residual value of at least 20 percent of its original cost; and if the owner-lessor puts up at least 20 percent of the cost in equity funds [Ref. 6: p. 27]. Figure 2.1 depicts a simple lease and the elements involved.

The pseudo lease, on the other hand, recognizes the lessee as the owner for tax purposes and because the lessor realizes no tax benefit, the lease rate cannot be reduced to make it competitive with a conventionally financed purchase. Thus, designation as a pseudo lease is unsatisfactory from both the lessee and lessor perspectives.

3. Types of Leases

There are various types of leases which must be considered, as well. Those of particular interest to this study are the finance or equipment lease, the operating or service lease, and the leveraged lease.

In the finance lease or equipment lease, the lessee acquires the use of an asset for most of its useful life.

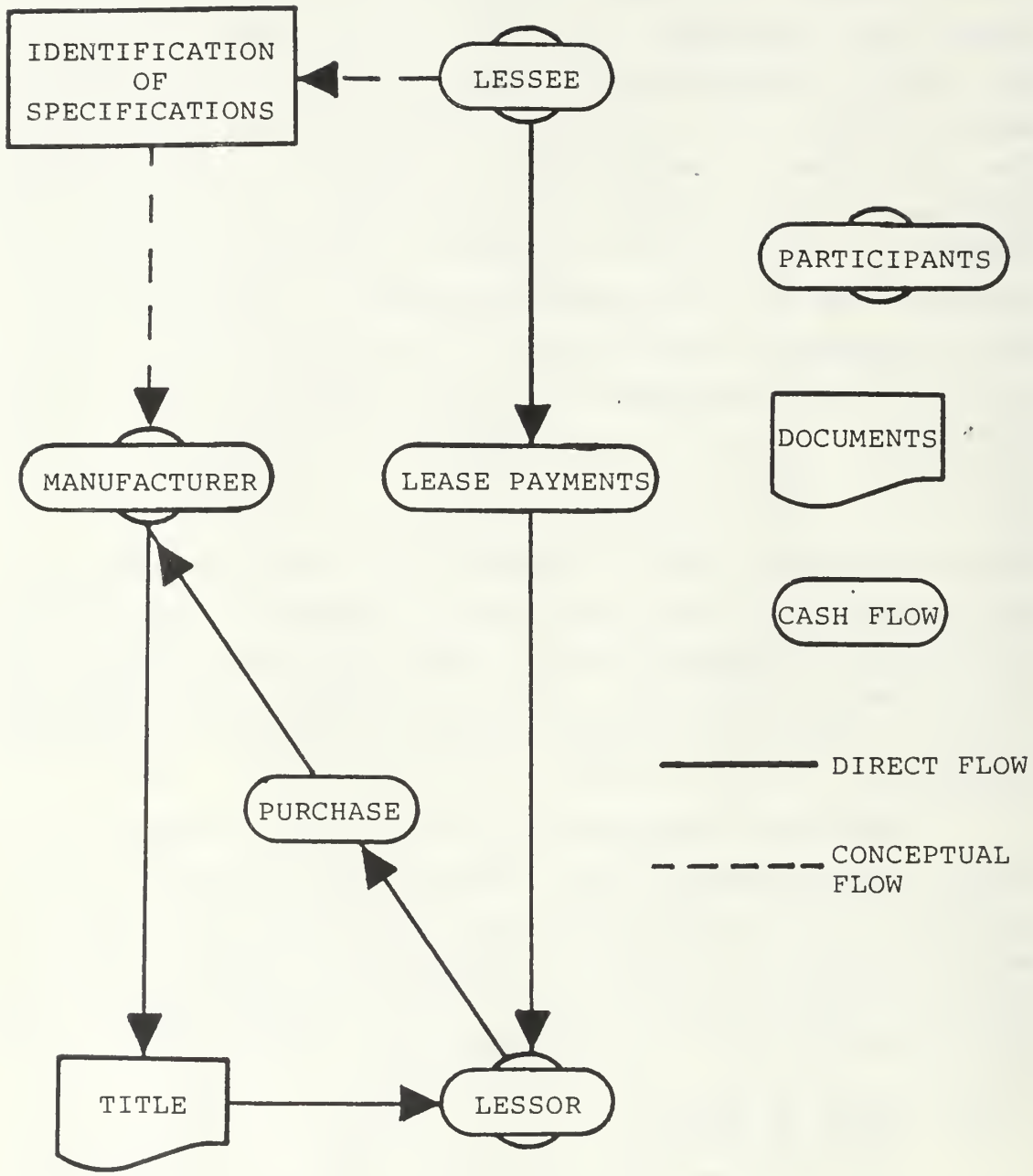

Figure 2-1 Diagram of a Simple Lease

The lessee assumes responsibility for the maintenance, taxes and insurance costs associated with the asset's use. The lessor's interests lie not in the management of the asset but in the return on investment the lease of the asset represents. [Ref. 7: p. 7] In terms of MILSATCOM, an equipment lease means the Government leases in-orbit satellites and then assumes control of those satellites. In such a system, it is up to the lessor to provide or contract out for the launch, launching services and Tracking, Telemetry and Control (TT&C) services during the satellite check out phase. Such activities are assumed to have occurred prior to the system being "delivered" to the Government. The cost of these services is, of course, included in the lease determination process [Ref. 5: p. 2]. Equipment leasing, then, provides virtually the same rights of control over an asset as does owning it.

The operating lease or service lease is a short-term lease, usually for a period of time considerably less than the leased asset's useful life. The lessor's return on investment depends not only on the original leasing agreement but also on the residual value of the asset and on subsequent renewals or renegotiations of the lease after the initial lease arrangement. The lessor generally pays taxes, insurance and maintenance costs on the asset [Ref. 7: p. 7]. In a satellite communications service lease, the lessee is provided with a specified amount of communication capacity. It is up to the lessor as to how that capacity is provided. Service leasing provides control through the lessor, only. The lessee's only rights are to the service which the equipment or property provides, not to the equipment or property itself.

The leveraged lease deserves a whole chapter unto itself. It is a complex, still evolving contractual leasing type which developed from the basic equipment lease, as

described above, in order to capitalize on the tax advantages of ownership without incurring the whole costs of that ownership. The leveraged lease introduces a third party to the leasing arrangement: a long-term lender. It is this third party who loans funds, usually a substantial portion of the asset's cost (50 to 80 percent is common), to the lessor for the purchase of the asset. [Ref. 6: p. 29] The lessor is thus enabled to lease the asset with a small initial outlay, possibly as low as 20 percent, while retaining the tax benefits of full ownership of the asset. The "leveraging" results in the splitting of the lease into debt and equity portions. The debt holder, the third party addressed above, is usually a large bank or insurance company who puts up most of the cost of the asset. In return, the debt holder receives most of the lease payments which represent interest and the reduction of principal. The equity holder, or the lessor, remains the legal owner of the asset and puts up the remaining initial cost and receives the rest of the rental income. And the lessor retains <u>all</u> the tax benefits associated with ownership. Also, at the end of the lease term, the lessor, in fact, owns the equipment. [Ref. 8: p. 132] Figure 2.2 depicts the participants and interactions of a simple leveraged lease arrangement. A leveraged lease can be much more complicated than the one depicted in Figure 2.2, however. Oftentimes, such a lease involves a multi-million dollar project which is so complex that experts in tax accounting and law are required to design and construct it.

Although these have been concise and somewhat general descriptions of the types of leases, they are sufficient for the analysis to be conducted herein. The intent of the discussion is to gain an appreciation of the different types of leases and who it is and how it is that benefits are derived from each.

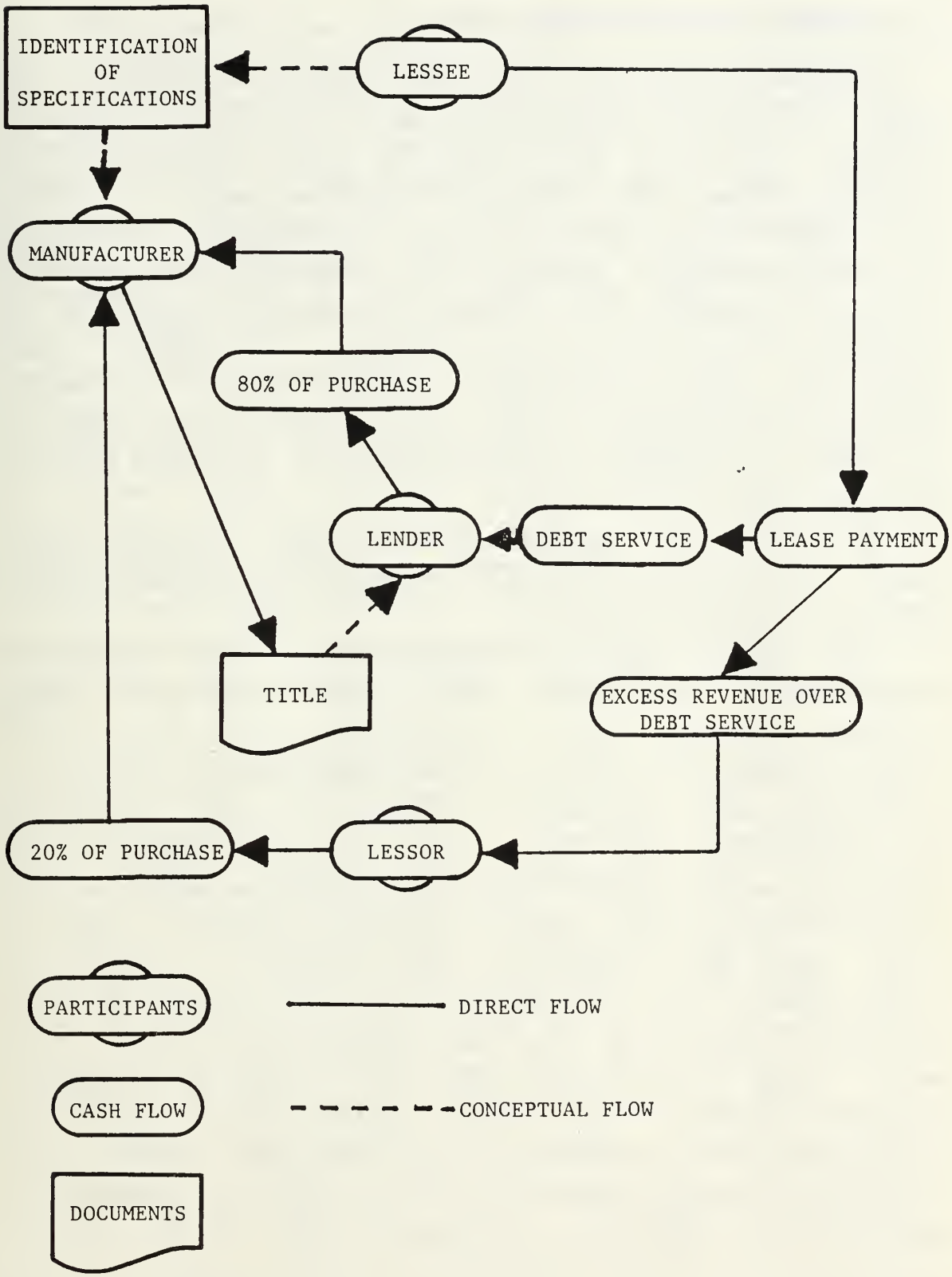

Figure 2-2 Diagram of a Simple Leveraged Lease

B. LEASING IN THE PRIVATE SECTOR

Equipment leasing in the private sector is not new. In fact, in the ship chartering industry it is rather ancient. However, the scope and intensity of the activity have increased tremendously in the last fifteen years. In 1972, new equipment worth over $11 billion was leased, accounting for approximately 14 percent of all business investment in capital equipment. The volume of leasing increased by 20 percent in that year, alone [Ref. 8: p. 190]. That percentage remained operative a decade later, as well. Equipment leasing grew by about 20 percent in 1983 [Ref. 9: p. 110], and leasing is now estimated to be a $150 billion per year activity [Ref. 10].

Why is it that leasing has become such a growing business? What economic factors have served to popularize this form of investment and why?

The leasing explosion dates back to 1963 when the Comptroller of the Currency ruled that banks could lease personal property. By the late sixties, many of the large banks had begun to exploit the new opportunities. Then, the liquidity squeeze of 1969-70 got many corporate treasurers interested and involved in the "new" financing methods. In 1971, the Federal Reserve Board allowed member banks to form holding companies to engage in equipment leasing. At that time, many small packaging firms sprang up to meet the rising demand for specialized leasing expertise and services. [Ref. 8: p. 136] The Investment Tax Credit (ITC) went a long way in encouraging the growth of equipment leasing, as well. The ITC is a reduction of a firm's tax liability which accrues after an investment is made in a "qualified" capital asset. The reduction is currently 10 percent of the amount invested [Ref. 11: p. 71].

Nothing went quite so far, though, in giving impetus to the leasing boom as did the passage of the Economic Recovery Tax Act (ERTA) of 1981. In essence, ERTA relaxed the specifications which a lease must meet to be classified a "true" lease by the IRS. The intent of ERTA was to assist small, struggling businesses by offering them incentives to purchase new equipment and machinery without requiring substantial amounts of capital investment [Ref. 6: p. 30]. Such companies were allowed to sell their tax benefits resulting from new purchases of equipment to more profitable companies. Then the equipment would be leased back by the original company. The more profitable companies became the lessors and reaped attractive rates of return through the purchase of tax benefits [Ref. 6: p. 31]. Such sale-leaseback arrangements became known as tax benefit transfers (TBTs) or safe harbor leasing. The "safe harbor" label was attached because the IRS agreed to consider the transactions exempt from most existing lease regulations [Ref. 12: p. 92].

Although the ERTA provisions enjoyed quick and extensive popularity within the business community, the costs were seen as prohibitive to the U.S. Treasury. Therefore, in 1982, the ERTA provisions were modified by the Tax Equity and Fiscal Responsibility Act (TEFRA). Simply stated, TEFRA reinstated the previous IRS requirements for true lease classification thereby closing the "safe harbor" [Ref. 13: p. 242]. However, because ERTA had attracted many firms into such leasing deals, they experienced firsthand the sometimes impressive tax advantages of leveraged leasing. For a company with profits to shelter, the yield from conventional leveraged leasing typically runs from fifteen to twenty percent [Ref. 12: p. 94]. Therefore, ERTA served to involve more companies in leveraged leasing and to lend greater respectability to leasing as an investment opportunity.

C. PUBLIC SECTOR LEASING OF MILSATCOM

The growth of leasing in the private sector has been charted. It is now time to consider its emergence in the public arena with special emphasis on its occurrence in the acquisition of MILSATCOM system capabilities.

Several near simultaneous yet unrelated events helped shape the emergence and evolution of the MILSATCOM lease versus buy question. The first was the failure of a tactical satellite program to support the Navy in 1972 [Ref. 14: p.127]. The second was a General Accounting Office (GAO) response to a House Appropriations Committee request [Ref. 15: p. 1].

1. GAPFILLER

In 1972 the failure of Tactical Satellite (TACSAT) I resulted in a gap in Navy tactical communications. To fill that gap on an interim basis, the Navy entered into a service or operating lease with COMSAT General Corporation to utilize part of the Maritime Satellite Communications (MARISAT) system. The Navy's leased services from the MARISAT system became known as GAPFILLER. GAPFILLER is a constellation of three satellites providing three-ocean coverage in geosynchronous orbit over the Atlantic, Pacific and Indian Oceans. The system provides UHF communications services to the Navy, Army, Air Force and Joint Chiefs of Staff as well as to commercial merchant marine fleet vessels. In 1973, The Navy signed a fixed price lease contract for $27.9 million covering a two year period with an option to renew the contract for a third. The Navy has been leasing the system ever since not only due to the 1972 TACSAT failure but also to fill "the gap" caused by delays in the Fleet Satellite Communications (FLTSATCOM) and the Leased Satellite (LEASAT) programs. The contract does run

out in 1985, however, and is expected to terminate at that time. As the contracts have been written, COMSAT retained responsibility for tracking and control stations, system operations and reliability of services. GAPFILLER represents "off the shelf" design and technology and, therefore, has no survivability features. [Ref. 14: pp. 128-130] However, it has performed well with system availability exceeding 99.9 percent. The system has supplemented MILSATCOM capacity and filled shortfalls created by failed and delayed systems [Ref. 7: p. 10].

2. Congressional Interest in MILSATCOM Acquisitions

GAPFILLER and the emergence of the commercial satellite industry in the United States spurred the interest of Congress as to the possible advantages of further leasing opportunities in the world of MILSATCOM systems. In October 1978, the House Appropriations Committee requested the General Accounting Office (GAO) to review the cost and schedule experiences of both DOD and the commercial sector's communications satellite programs. The GAO findings were somewhat disheartening. It seemed that the average costs to develop, procure and launch the military's latest generations of communications satellites were greater than the most expensive commercial satellites. Systems included in the study were the Navy's FLTSATCOM system and the Defense Satellite Communications System (DSCS II and III) on the military side and WESTAR, COMSTAR and INTELSAT I to IV on the commercial side. [Ref. 15: p. 1] The military's higher costs were chalked up to the more sophisticated design requirements of the military, more costly development programs which included many design and developmental changes, and schedule delays which resulted in the requirement for short-term, operational fixes, such as the one which resulted in the leasing of GAPFILLER. In other words,

the military's increased technological complexity resulted in greater technical risk and higher program costs. The commercial satellite systems tended to be more conservative in design and, therefore, more manageable in production. [Ref. 15: p. 3] However, before the report had even been requested, the House of Representatives Defense Appropriations Bill for FY 1978 had included this statement:

> "...The committee recommends a major policy change. Henceforth, DOD should, in the committee's view, lease not buy communications satellites. These should be based upon incremental rather than revolutionary improvements, should be fully competitve, and should be so designed that individual DOD commands or programs will be charged the full costs of services received." [Ref. 16: p. 15]

3. LEASAT

The Navy entered into another leasing arrangement due to the pressures exerted by Congress and the seeming advantages derived from such an economic instrument [Ref. 17: p. 624]. LEASAT, the Navy's Leased Satellite system, provides worldwide UHF communications services to ships, submarines, Navy aircraft and other mobile users. It is a five satellite system, four in geosynchronous orbit with one ground spare. Its design life is ten years and the system is designed to replace GAPFILLER and FLTSATCOM. [Ref. 17: pp. 640-641] LEASAT is leased directly from Hughes Communications Services, Incorporated (HCSI), a fully owned subsidiary of Hughes Aircraft Corporation. The lease is for a five year period, $67 million per year or a total of $335 million for the five years. The contract is a leveraged leasing arrangement whereby HCSI sells the satellites to a group of banks after the satellites are launched and tested in orbit. HCSI then leases the system back from the banks for seven years simultaneously leasing it to the Navy for

five years. After the five years, HCSI may lease services to other users or renegotiate and extend the lease to the Navy. [Ref. 7: pp. 16-17] LEASAT has incorporated substantial Government Furnished Equipment (GFE) including dual channel onboard processors for each spacecraft and encryption devices. The system has less capability than FLTSATCOM due largely to the elimination of some of the Air Force mission requirements of FLTSATCOM. [Ref. 17: p. 642] LEASAT was designed for space shuttle launch and originally scheduled for a 1980 launch. However, due to Space Shuttle delays, the first launch of a LEASAT bird took place in August 1984. The slippage required the renegotiation of the contract between the Navy and HCSI. [Ref. 18]

LEASAT is the most costly and most sophisticated MILSATCOM system to be leased by the DOD. Its effectiveness as a system cannot yet be determined, but the methodology used in choosing to lease the system rather than purchase it was based on the decision model which is the subject of this thesis. [Ref. 18]

D. CONCLUSION

The reliable performance of GAPFILLER which had little to do with its being a leased system or not, coupled with the emergence of the commercial satellite industry in the late 1970s led some within DOD and Congress to herald the benefits of leasing as the more cost effective means of acquiring MILSATCOM services. However, all the pieces of the puzzle have not yet fallen into place. In chapter three, the attractiveness of the lease option will be further considered. Also, the evolution of Congressional interest and position concerning lease versus buy will be followed and the standard arguments for both options will be addressed fully.

III. FACTORS FOR CONSIDERATION IN A LEASE VERSUS BUY ASSESSMENT

The Congressional hearings on the 1978 Defense Appropriations Bill did not leave much to the discretion of the DOD. The Navy was directed to lease rather than buy its next comunications satellite system [Ref. 19: p. 7]. The reasons cited for this recommendation were "the record of poor DOD program management, cost overruns, schedule delays and failure to provide acceptable service" [Ref. 16: p. 15]. The basis for this position was a report published by the House Appropriations Committee Surveys and Investigations Team which criticized DOD management of space-based communications systems. The report cited the following factors in support of leasing required services:

> "From a DOD management standpoint there are several potential advantages to leasing service:
> A. A lease/buy analysis should show that leasing is cheaper;
> B. "Low Ball" bidding is discouraged;
> C. Service will probably be obtained quicker and (be) more responsive to user needs;
> D. Cuts government bureaucratic overhead, including support;
> E. Relies on competitive marketplace to control total system costs;
> F. No money is obligated until service is rendered;
> G. Communications service will not be allowed as a "Free Good" to users;
> H. Reduces technical content of top-level DOD decisions;
> I. Risk assessment is performed in the private sector;
> J. Total system costs are immediately visible." [Ref. 16: pp. 15-16]

There are three aspects of the lease versus buy decision which are generally addressed in MILSATCOM lease/buy analyses: [Ref. 5: p. E2]. the technical, financial and management implications of each option. The position of the

House of Representatives Appropriations Committee, as stated above, seems to be based on financial and management considerations, primarily. But all the aspects require consideration. Each of these three areas is addressed individually in this chapter. However, because it is so difficult to separate the technical issues from the management issues, the two discussions tend to overlap.

A. TECHNICAL ASPECTS OF THE LEASE VERSUS BUY EVALUATION

First, the technical considerations relating to the lease and buy alternatives stem from the technological requirements of MILSATCOM systems and the risks involved with them. As the technology of a system approaches the state of the art, the cost of the system increases dramatically [Ref. 20: p. 78]. The very nature of MILSATCOM system objectives usually requires pursuing the leading edge in technological capabilities [Ref. 21: p. 56]. This requirement for state of the art technology results in increased technical risks [Ref. 7: p. 25]. and, therefore, has repercussions on the lease/buy decision.

For the lease, requirements are usually stated in terms of service and performance to be provided by the satellite system [Ref. 5: p. E2]. Since satellite specifications are considered in performance terms rather than design, the system contractor may be able to realize significant savings in optimizing design and construction without being subjected to the rigors of a Government purchase contract which must be justified and rejustified throughout the design and development phases. The lease strategy usually requires that the design be "frozen" at the time of contract award thereby allowing for a more smoothly running program with fewer chances for delay due to design changes. [Ref. 5: p. 19]

For the buy alternative, requirements are almost always written in terms of design specificationsinstead of performance specifications [Ref. 5: p. E2]. The design specifications may be changed to accommodate changing requirements and/or technology. Such changes most often involve many layers of review for ultimate approval. Program delays and increased costs usually result [Ref. 5: p. 19].

Therefore, in the technical performance area, there are tradeoffs between the two alternatives, the lease and the buy. With the lease, the benefits are generally thought to be a more smoothly running program with fewer delays. The lease is less flexible, however, in the development phase because its design and specifications are held frozen to the time of the contract award. Of course, the lease contract can be modified to accommodate changes, but the attendant cost growth and schedule slippages are oftentimes prohibitive. [Ref. 5: p. 20] The buy alternative allows for greater technical flexibility but at the potential expense of program delays and increased costs. The lease alternative, on the other hand, tends to constrain the performance of MILSATCOM systems to achievable, demonstrated technology.

To review, the technical aspects of the lease and buy alternatives center around "off the shelf" versus state of the art technologies. There is actually a spectrum of alternatives between these two end points. The objective of any decision model is to assist the decision maker in arriving at the optimal choice of technologies, cost and performance capability. [Ref. 22: p. 13]

B. MANAGEMENT ASPECTS OF THE LEASE VERSUS BUY EVALUATION

The managerial considerations impacting the MILSATCOM system lease/buy decision are numerous. They are not unrelated to the technical considerations and, oftentimes, in

fact, go hand in hand with the technical aspects as well as the financial.

With a lease, the satellite services can often be obtained more quickly because they generally represent proven, "off the shelf" technology [Ref. 23: p. 24]. Because the lease is based on performance rather than design specifications, the manufacturer is allowed to achieve a greater efficiency in the system's design and construction [Ref. 5: p. 19]. Because the lease allows for predictable, periodic cash flows as determined in the contract, management requirements outside the Department of Defense are lessened. The lease does not require annual review in the Planning, Programming and Budgeting System (PPBS) and, therefore, requires less administrative and management efforts [Ref. 24: p. 3]. Also, internal to the DOD, the contractual process, itself, is simplified because MILSATCOM systems need not compete with higher priority programs for procurement funding [Ref. 25: p. 5]. The funding aspects will be amplified further in the next section on the financial aspects of the lease/buy decision.

The lease option also lessens management overhead both in the planning and administrative phases of the program because once the specifications are determined and contractually agreed to, it is up to the manufacturer and lessor to meet those requirements [Ref. 24: p. 3]. Management requirements on the part of the military program sponsors are, therefore, minimized once the contract has been let. The tradeoff to this lessening of management overhead is the flexibility and control of design which the buy option affords the Government [Ref. 5: p. E4].

Other management considerations and decisions come at the point of contract negotiation [Ref. 5: p. E5]. They pertain to leasing contracts in particular but may impinge on the buy contract decision, as well. Such considerations

include the contract type, whether it is fixed price, cost plus fixed fee or some variation of the two; the payment plan; and the period of the lease contract, and therefore, the period of performance of the system. Also, incentive and penalty provisions must be specified, defining exactly what is considered satisfactory versus unsatisactory performance of the system. These provisions must also specify Government versus contractor liabilities. Last, the benefits of and extent of use of Government Furnished Equipment (GFE) must be considered and contracted for as well as logistics and maintenance support to be provided for the system. [Ref. 16: pp. 31-35]

In summary, the managerial aspects to be considered in the lease versus buy MILSATCOM system decision synthesize into the tradeoff between managerial control and the costs associated with such control. With the lease option, there is reduced management costs to the Government in terms of personnel assigned and administrative costs associated with higher staffing levels. What is lost with the lease option is the technical and managerial control which is derived from the buy option. Although a purchase is more costly in terms of managerial and administrative overhead, the cogent question remains: is this greater cost offset by the benefits reaped in the area of management control? There is also the question of whether the seeming benefits of the lease can be derived from a buy alternative if only the specifications and contract are devised in order to achieve those benefits. In other words, if the specifications are written and the contract negotiated such that a particular buy option would also freeze design and/or performance specifications and would ensure the manufacturer the same amount of flexibility and control in development and production as a lease would afford, could not management costs be kept lower and savings accrue to the Government as in the case of

a lease? In short, there is a whole gamut of choices and decisions on the "continuum" from a simple lease to a simple buy. Neither alternative has aspects that cannot be achieved through the other alternative given a willingness to absorb increased costs or to accept less technical and/or managerial control. These issues and questions will be discussed more thoroughly in subsequent chapters.

C. FINANCIAL ASPECTS OF THE LEASE VERSUS BUY EVALUATION

The financial aspects of the lease/buy decision are more complex and somewhat convoluted. There are both funding and cost factors to be considered within the financial category.

First, the funding dissimilarities between the two options revolve around what "color" of monies are required for each and at what time in the lifecycle of the satellite system the funds are required [Ref. 5: p. E3]. The lease option spreads costs over the lifetime of the lease. The dollars required to pay the lease are Operations and Maintenance (O&M) funds. The uniform flow of O&M funds occurs concurrently with the in-orbit service period. [Ref. 5: p. 7]. The lease option costs less on an annual basis, but the total cost of the lease package is higher due to insurance costs, the cost of capital and return on investment incurred by and due to the lessor [Ref. 5: p. E3]. Also, because the lease option spreads the cost of the system over several years, there can be a problem of obligating future administrations by the contractual lease and a loss of flexibility with respect to the allocation of O&M monies [Ref. 5: p. 11]. However, some proponents of leasing consider its cost advantages to be the limits it places on cost growth [Ref. 24: p. 3] and its lower processing and handling costs [Ref. 16: p. 15].

With the buy alternative, on the other hand, procurement monies must be justified and budgeted via the annual budget process [Ref. 16: p. 16]. With purchases, large upfront outlays are required during the Research and Development (R&D) phase, and an annual review of the program by DOD and Congress may jeopardize the system's acquisition each year [Ref. 24: p. 3]. In other words, with the buy option, a system will come under much greater question and scrutiny during the budgeting process.

Such are the funding considerations between the lease and buy alternatives. There are also what may be called cost considerations which include risk assessment [Ref. 7: p. 24] and tax considerations [Ref. 11: p. 43]. They are addressed separately below.

1. Financial Risks

When addressing space-based communications systems, risk must be considered. There are two types of risk involved in such systems, technical risk and financial risk. Technical risk is simply that risk which is assumed by the designers and producers of systems which push the state of the art. Financial risk is closely linked to technical risk. It represents the investors' potential dollars at risk with the deployment of a particular system. Technical and financial risk are related in that the higher the technical risk, the greater the financial risk. When a MILSATCOM system does not perform to requirements, the replacement or partial replacement of the system and the costs involved in such replacement represent the financial risk assumed by the owner of the system. [Ref. 7: pp. 25-26]

The primary difference between the MILSATCOM system lease and buy alternatives is thought by some to be merely a question of who bears the financial risks of technological

failure [Ref. 5: p. 20]. As the rationale goes, under a lease, the financial burden of technological risk falls upon the private sector, i.e. the stockholders of the lessor company. Under the buy option the risk and burden fall upon the Government, and ultimately, on the taxpayers. With such a perspective, the lease/buy decision becomes much simpler in that decision variables cluster around private sector versus public sector risk assumption and the equity and efficiency questions attendant to such discussions. [Ref. 7: pp. 24-26]

In any case, the financial risks associated with MILSATCOM systems represent major concerns in the lease/buy analysis. The cost of such systems makes replacement a major consideration and the inherent financial risk high. "Economic agents are risk averse. This means they will not bear risk voluntarily, unless paid to do so," [Ref. 7: p. 26]. Such is the position of companies entertaining the possibility of entering the MILSATCOM system arena. What then is their inducement? With financial risks potentially so high, why does any firm decide to assume them? What inducements and incentives are present to attract commercial entities into the world of MILSATCOM system leasing? These questions are answered simply: tax incentives.

2. Tax Incentives

Although capital leasing has been increasing dramatically since the early 1970s as outlined in the previous chapter, it has been legislation in this decade which has given impetus to its notable increase in the public sector. [Ref. 25: p. 3]

There are various tax implications which make leasing MILSATCOM systems to the Government attractive to commercial firms. The leveraged lease is dependent upon these tax benefits to provide the lessor with an acceptable

rate of return, while providing the lessee with a lease rate that is below the normal cost of financing [Ref. 26: p. 33]. In the leveraged lease, the lessor's rate of return is derived, principally, from two sources: (1) whatever excess there is from the lease payment, itself, after principal and interest have been paid to the debt holder and (2) the tax benefits accruing from ownership of the system [Ref. 11: p. 61].

These tax benefits fall into two categories. First, there is depreciation. Accounting for depreciation according to generally accepted accounting principles is "a system of accounting which aims to distribute the cost or other basic value of tangible capital assets, less salvage value (if any), over the estimated useful life of the unit in a systematic and rational way" [Ref. 27: p. 4]. The central issues surrounding the depreciation question are the period of depreciation and the method of allocation used. [Ref. 27: p. 5]

The Economic Recovery Tax Act of 1981 (ERTA) greatly affected both the period of depreciation and the method of allocation authorized for capital investments. Under ERTA, depreciable property could be classified into five property classes, each of which generally provides increased depreciation allowances for most business property. What ERTA did through this Accelerated Cost Recovery System (ACRS) was allow firms to ignore traditional useful life and salvage value concepts in favor of a shortened period of depreciation. The Act also affected the technique or method of allocation to be used in estimating depreciation costs and increased the percentage of decreasing-charge depreciation methods allowed [Ref. 28: pp. 20-21]. All decreasing-charge methods, the most common of which are the declining-balance and the sum-of-the-years'-digits methods, assign a larger amount of the cost of a depreciable asset to the earlier

years of its depreciable life [Ref. 27: p. 101]. What these two provisions of ERTA have done is enhance the attractiveness of leasing for equity holders. Although the Tax Equity and Financial Responsibility Act of 1982 (TEFRA) repealed some aspects of ERTA, the changes discussed above which significantly affected the period of depreciation and the method of allocation through ACRS remained substantially intact [Ref. 28: p. 22]. Therefore, since ERTA and ACRS, much greater depreciation amounts can be written off in the early years of the lifecycle of a capital investment thereby allowing the equity holder greater opportunities for investment.

The second category of tax benefit accruing to the equity holder of a MILSATCOM system is the Investment Tax Credit (ITC). Tax credits granted on the basis of investment outlays were first introduced in the United States in 1962 with the Investment Tax Credit Act of 1962 [Ref. 29: p. 2]. What the ITC does is reduce the amount of taxes required of businesses purchasing capital assets. In effect, this allows the lessor to claim a specified percentage of new capital investment as a credit against income taxable in the current year [Ref. 29: p. 51]. The present ITC amount is ten percent [Ref. 28: p. 21] which means that for a $1,000,000 MILSATCOM system bought in 1985, the equity holder could deduct $100,000 from its 1985 taxes due to the ITC authorized by that amount of capital investment.

Thus, in recent years the attractiveness of leveraged leases contracted with Government agencies has increased substantially. And though financial and technical risks may be high for MILSATCOM systems, the tax incentives accruing to the lessor are more than enough to compensate for the risks involved. Such a statement is attested to by the recent LEASAT contract in which several commercial

satellite producers submitted bids for the system. [Ref. 19: pp. 7-10]

There are tradeoffs to be made in any lease/buy decision. Each alternative has its strengths and weaknesses when considered from the technical, the management and the financial perspectives. Judging from the quotation which begins this chapter, portions of the Congress were leaning very heavily in favor of the lease option as the preferred means of acquiring MILSATCOM systems in the late 1970's. However, by 1983, there was a shift in thinking. [Ref. 6: p. 58] The obvious question is: why?

D. GROWING CONGRESSIONAL CONCERN AND ACTION IN THE LEASE/BUY ARENA

In 1983, the General Accounting Office (GAO) was requested by Congress to "review the practices and procedures followed by the Government in its long-term leasing of capital equipment" [Ref. 25: p. 1]. The GAO study in response to this request limited its focus to four military programs, the Navy's noncombatant auxiliary cargo (TAKX) and tanker (T-5) ships and the Air Force's trainer (CT-39 replacement) and Tanker Transport Bomber (TTB) aircraft. The specific issues addressed in the study included:

1. The magnitude of long-term leasing in the public sector, and particularly within DOD;
2. The reasons the services would rather lease than purchase capital equipment;
3. The potential effect of long-term leasing on military capabilities;
4. The adequacy of the lease versus buy economic analyses used by the services;
5. The need for full disclosure of long-term leasing costs; and

6. The possible need for legislative and administrative changes to improve congressional oversight of long-term leasing programs. [Ref. 25]

Quoting from the report in part:

> "In general, a long-term leasing program that provides for leasing an asset for its useful life will be more expensive than purchasing the asset because a third party--the lessor--is involved; whereas, in a procurement arrangement, only the purchaser and the manufacturer are involved. Thus, it would be expected that the third party will require a return on his investment and this will be passed on to the lessee as an added expense. If the lessor's required rate of return exceeds the Government's discount rate, the yield on Government securities, leasing will be more expensive than purchasing. The reason is that a lessor would expect to earn a higher rate of return on his investment than he could earn by investing in Government securities and his added expense is passed on to the lessee." [Ref. 25: p. 8]

The GAO survey focused attention on the question of what impact the leasing of capital assets by tax-exempt entities, i.e. public sector entities, has on the Federal economy as a whole [Ref. 11: p. 57]. The report coincided with and reinforced growing Congressional concern over two central lease/buy issues: (1) the magnitude of the loss of tax revenues resulting from capital leases entered into by Federal agencies; and (2) the lack of Congressional oversight and control of leasing by such agencies. What Congress was concerned about, then, was the "hidden" costs of public sector leasing arrangements, "hidden" in the sense that they are invisible until the tax benefits accruing to the lessor are considered as losses to the Treasury and, therefore, costs to the Government. Secondarily, Congress was concerned about its lack of oversight of this type of Federal "tax expenditure" or loss of revenue. [Ref. 6: pp. 58-60]

E. WHY LEASING REMAINS ATTRACTIVE TO FEDERAL AGENCIES

Despite Congress' growing skepticism of leasing as a cost effective method of acquiring military and non-DOD services, the option remains attractive at the agency level. Why?

The 1983 GAO report cited the following factors as significant in the continued attractiveness of the lease option to Federal agencies [Ref. 25: Appendix I, p. 1]. First, the costs of a project can be spread evenly over a period of years. Second, the obligations incurred are against working capital funds, i.e. O&M funds, versus procurement funds. Third, the amount of scrutiny given by Congress to purchases had been much greater than that given to leasing arrangements. And, last, leasing almost always appears less costly because part of the total cost shifts from the agency's budget to the Treasury in the form of reduced tax revenues.

F. CONCLUSION

In summary, the purpose of this chapter has been to address the familiar and oft cited aspects of any lease versus buy assessment identifying, in particular, the dissimilarities of the two options in the areas of technical, managerial and financial considerations. In addition, the shift in Congressional opinion on the issues and the reasons for that shift have been addressed to set the stage for Chapter IV. The specific model used by the Navy in its most recent lease versus buy decision for a space-based satellite communications system will be the central topic in the following chapter. The correct criteria for any such decision model must be to determine the real costs to the economy of all alternatives and to facilitate the comparison of and assist the decision maker in comparing the various choices.

IV. ANALYSIS OF THE NAVY'S LEASE/BUY DECISION MODEL

With the background now in hand, it is time to consider the decision model presently used by the Navy in making its MILSATCOM systems lease versus buy evaluations and choices. First, this chapter will formulate a general lease versus buy decision model, then the Navy's model will be juxtaposed against this general model to ascertain its quantitative strengths and weaknesses.

A. THE GENERAL LEASE/BUY METHODOLOGY

The General Accounting Office (GAO) set out a four step, general lease/buy decision model when it addressed the overall methodology used by the National Aeronautics and Space Administration (NASA) in making its lease/purchase comparison for the Tracking and Data Relay Satellite System (TDRSS). [Ref. 30: p. 1] The general model described below is wholly based on that GAO model.

The first step according to GAO is the identification of all cost categories associated with each of the alternatives, the lease and the buy, during the economic life of the system being considered. This portion of the modeling task can be quite extensive especially for a highly complex system with a large number of cost categories. [Ref. 30: p. 5]

The second step is to estimate the magnitude of each cost category and the time in which the costs will be incurred. Of course, this must be done for both the lease and the buy alternatives. In addition, any offsetting cash flows, such as tax implications, which are generated as a result of incurring these costs must likewise be estimated

including their magnitude and timing. Once this information is garnered accurate estimates of the net cost implications of each of the two alternatives can be derived. Costs whose timing and amount are the same under both the lease and buy options may be excluded from the analysis as they will have no bearing on the relative attractiveness, or unattractiveness, of either alternative. [Ref. 30: p. 5]

After the costs for the lease and buy options have been identified and time phased, by year, over the useful life of the system being considered, the annual cost figures must then be converted into their present values. This, the third step of the process, takes into account the time value of money. [Ref. 30: p. 6]

The final step comes after the costs for both alternatives have been converted into present value terms. The two amounts are then compared and the alternative with the lower present value costs is considered the more economically efficient. [Ref. 30: p. 6]

B. THE NAVY'S MODEL

The model currently used by the Navy in assessing its lease versus buy MILSATCOM systems decisions was developed for use on an IBM-compatible personal computer with Lotus 1-2-3 software. [Ref. 31: p. 2]. Dr. Patricia M. Dinneen while working at RAND Corporation formulated the model program [Ref. 18], and in the opinion of the author, she devised a flexible yet sophisticated tool by which to evaluate quantitatively MILSATCOM lease versus buy choices. The model's stated objective is to:

"Provide a general, flexible parametric model to assist government and corporate decision makers in determining when to lease rather than buy. The model can be used by the Government to determine conditions under which leasing is less costly than buying and by the private firm to determine when leasing is more profitable than selling." [Ref. 31: p. 1]

To ascertain whether the model matches the general requirements set forth by GAO in its 1976 report outlined above, Tables I and II reflect the specific information suggested by GAO and the inputs available in Dr. Dinneen's decision model.

TABLE I

The General GAO Lease/Buy Model

COST CATEGORIES INCLUDED IN THE MODEL:

Design phase contracts costs
Launch vehicles costs
Ground station facilities costs
Ground station equipment costs
Ground station operation and maintenance costs
Lease payments costs
Supplemental network hardware costs
Supplemental network operation and maintenance costs
Project support costs
Personnel staffing costs

$$$$$$$$$$$$$$$ TOTAL COSTS $$$$$$$$$$$$$$$

OTHER INPUTS TO THE MODEL:

Estimated recovery of Federal income tax
Various Government discount rates
Net undiscounted cost to the Government

The tables include the specific wording used in the GAO report on TDRSS [Ref. 30: p. 11] and in the Navy's decision model [Ref. 31: pp. 2-7]. Although the cost category

TABLE II

The Navy's Lease/Buy Model

COST CATEGORIES INCLUDED IN THE MODEL:

Research, development, test and evaluation costs
Spacecraft cost
Launch vehicle cost
Ground equipment costs=cost of ground station control facilities
Seller's/Lessor's other costs:
-Insurance
-General administration expenses
-Tracking, Telemetry and Control (TT&C) costs
Seller's profit rate and price in the case of a buy

$$$$$$$$$$$$$ TOTAL COSTS $$$$$$$$$$$$$

OTHER INPUTS OF THE MODEL:

Corporate tax rate
Government tax rate
In the case of a buy:
-Seller's discount rate
-Annual profile of costs and payments
In the case of a lease:
-Interest rate on lessor's loan
-Investment Tax Credit
-Depreciation method utilized
-Lessor's discount rate
-Annual profile of costs and payments
-Period over which lessor pays back loan

descriptions vary slightly between the two models, substantively, the cost inputs are the same. However, as can be seen in Table II, the Navy model allows for a greater number and flexibility of inputs which can be utilized to account more accurately for decision variables and parameters. However, this flexibility of inputs can also be manipulated to skew the results of the analysis.

Due to this variety of inputs, the outputs of the two models vary widely. For the GAO general model [Ref. 30: p. 11], the only outputs are the "Net cost to the Government, discounted at XX percent" for the lease and the buy options,

separately. For Dr. Dinneen's model, the outputs are much more extensive.[2] The specific outputs for the Navy's model are separated and listed by alternative. The buy outputs are [Ref. 31: pp. 7-9] :

1. Seller's progress payments--the schedule and amount of annual progress payments.
2. Seller's costs--the schedule and amount of annual costs.
3. Seller's taxes--the schedule and amount of annual taxes.
4. Seller's cash flow--the schedule and amount of annual cash flows.
5. Seller's PDV$--the schedule and amount of annual, present discounted value of seller's cash flow, using the seller's discount rate.
6. Government cash flow--the schedule and amount of annual cash flow.
7. Government's PDV$--the schedule and amount of annual present discounted value of Government's cash flow, using the Government's discount rate.
8. Agency's PDV$--the schedule and amount of annual present discounted value of the Agency's cash flow. This amount will differ from the Government's PDV$

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[2]The Navy's decision model includes two different methods of use. The first method, referred to as the "closed form", allows the user to specify the various inputs. Given these values, the model calculates various outputs, e.g. the net cash flows and total costs to the Government under a lease compared to a buy, and the net cash flows and internal rates of return to the manufacturer, under a lease compared to a sale. The second or "open form" method, allows the user to specify the various inputs, and the model calculates the Government's net cash flow and total price under a buy. Having calculated the purchase price, the model then solves for the corresponding lease price such that the Government would be indifferent between leasing and buying. Once this lease price has been determined, the model solves for the lessor's internal rate of return and compares it with that earned under a sale. By incorporating two methods, the Dinneen model can be used to analyze lease/buy decisions from various points of view: the Government's, the Agency's, and the manufacturer's. [Ref. 31: p.1]

because the seller's taxes are excluded.

9. Seller's IRR--the Internal Rate of Return, defined as that discount rate such that the present value of the seller's cash flow is zero.

The lease outputs are [Ref. 31: p.9] :

1. Lease payment/target--the amount of annual lease payments, calculated on the basis of lessor's costs, discount rate and the number of lease years.
2. Annual loan payment--the amount of annual loan payments, calculated on the basis of the lessor's costs, interest rate and number of loan years.
3. Lease payments--the schedule and amount of annual lease payments.
4. Lessor's costs--the schedule and amount of annual and administrative costs.
5. Lessor's loan payments--the schedule and amount of annual loan payments spread over the designated number of loan years.

Again, in the opinion of the author, this decision model is a "user friendly" tool, useful in the evaluation of quantitative factors of the lease/buy decision. The model also measures up very well to the criteria set for such models by the GAO in Reference 29.

C. CONCLUSION

The quantitative cost categories associated with the lease/buy decision are included in the Navy's model. Setting the magnitude of these costs is left to the model user. Because the user can vary these amounts, the model is especially effective and useful in conducting sensitivity analyses. The model also uses standard present value formulae and is, therefore, effective in accurately representing the time value of money.

However, to choose between a lease and a purchase of a MILSATCOM system based solely on the inputs and outputs of this model is to trivialize the lease/buy evaluation process. Although the model is straightforward and flexible in its applications, the value and validity of its outputs depend not only on the accuracy and exactness of the inputs, but also on the implicit assumptions which form the foundation of the model methodology.

The next chapter will deal extensively with the qualitative factors not addressed adequately in this model and will make a case that is has a presumptive bias toward leasing as the preferred option.

V. SHORTCOMINGS OF THE PRESENT MODEL

The Navy's lease versus buy decision model satisfactorily meets the quantitative requirements set forth in the General Accounting Office's general lease/buy methodology, as discussed in the last chapter. However, there are serious shortcomings to the model which, in the opinion of the author, require consideration in this study's analysis of the model. These shortcomings fall into three categories for consideration:

1. Faulty underlying assumptions on which the model is based;
2. Important considerations in the MILSATCOM system decision problem which are not adequately addressed in the Navy's decision model; and
3. The comparison the model makes is deceptive in that it does not compare two financing mechanisms which acquire the same MILSATCOM system. Rather, the lease is assumed to be an instrument whereby all specifications are considered fixed and the buy is assumed to allow total flexibility for change.

In the opinion of the author, this model is seriously deficient because of these shortcomings and this chapter will address each area of deficiency, individually.

A. FAULTY ASSUMPTIONS UNDERLYING THE NAVY'S LEASE/BUY MODEL

In the author's opinion, although the Navy's lease versus buy decision model follows the general guidelines set forth by the GAO, its rationale is predisposed toward the lease option. This predisposition results from two underlying assumptions to the model,

1. The model assumes that the economic nature of public sector leasing is the same as that for the private sector; and
2. The model does not adequately account for the role of discounting in public sector decisions.

The Navy's model is deficient because of these faulty, underlying assumptions and the problems these erroneous bases produce.

The important distinction which the Dinneen model fails to take into account is that public sector leasing is fundamentally different from private sector leasing. In the private sector, leasing is used simply as a method of reducing the costs of financing an asset [Ref. 8: p. 132]. This reduction in financing costs is achieved by the lessee "trading" the depreciation on an asset to another entity (the lessor) whose tax benefits from the depreciation are greater than those accruing to the asset user (the lessee). In exchange for this "trade," the lessor passes on its savings to the lessee in the form of lower lease payments. [Ref. 11: pp. 32-34] The crucial difference from the lessee's point of view is that the effective interest rate on the lease is less than that which could be obtained from its best conventional debt alternative [Ref. 32: p. 4].

The question which emerges in any public sector lease/buy decision analysis is, do these lease savings accrue to the Government in public sector leasing arrangements, as well? Simply stated, the answer is no [Ref. 32: p. 9].

Capital leasing is basically a private sector device. It is a method used by private firms to reduce the costs of borrowed funds. However, the Government's interest payments do not correspond to their private sector counterparts. They are more like transfers between individuals in the private sector since they are taxation dollars, primarily, received from individuals within the private sector being

paid to private sector financing institutions via the Government as intermediary. Unlike a private sector firm whose revenue represents earnings which will be used in various ways to create more revenue or be distributed to its shareholders, the Government's revenues represent funds which come from the people and will, through an intricate decision process, be spent and consumed by all or a significant portion of the people, all in the name of the "common good." [Ref. 22: pp. 3-5] It is not clear that reduced interest rates which accrue to a private sector lessee have any meaning in the public sector. And, in fact, minimizing Government interest payments by leasing is unlikely to save any significant amount of resources. [Ref. 32: p. 11]

There is a valid argument to be made, however, that leasing <u>does</u> act to reduce an Agency's budget outlays by minimizing its interest payments [Ref. I: pp. 5-6]. Therefore, the costs to the <u>Navy</u> of a leased MILSATCOM system may, in fact, be less than the costs of procuring that same system because these costs exclude the tax implications of the lease on the <u>whole</u> of the Government. In other words, leasing may well look to be the preferred alternative from the vantage of the Agency, in this case the Navy, because that Agency's budgetary outlay is lessened. However, when tax implications and the costs of leasing to the <u>whole</u> Government are considered, leasing does not then look to be the preferred alternative for acquiring MILSATCOM systems. Therefore, the entire lease versus buy question hinges on which perspective one takes--that of the Agency which strives to keep its particular costs down or that of the <u>whole</u> Government which strives equally to keep its overall costs down. It is the author's opinion that the <u>real</u> costs of leasing to the <u>whole</u> Government must be the criterion used when considering lease versus buy decisions not only by the Navy but other federal agencies, as well.

Likewise, in the opinion of the author, the Dinneen model fails to focus on the real resource costs involved in acquiring communications capabilities. In fact, the acquisition of such capabilities whether leased or bought requires the same amount of resource consumption. The diversion of real resources away from the private sector and to the public sector is the same in either case. Leasing of MILSATCOM systems does not, in any way, reduce the amount of private output which must be sacrificed to produce and acquire MILSATCOM services.

In fact, if one looks at the total costs of procurement versus leasing to the Government, leasing tends to increase costs. "The incremental costs of transferring resources through the established mechanisms of taxation and direct debt are fairly low while the resource costs of transferring resources via leasing appear to be quite high," [Ref. 32: pp. 11-12]. In other words, transferring resources from the private to the public sectors through a leasing arrangement consumes a significant volume of resources. Thus, for this reason alone, long-term capital leasing should usually be avoided because it is a less efficient means of accomplishing the Navy's mission. [Ref. 32: p. 12]

If this is the case, however, how is it that leasing has, at times, been found through lease versus buy evaluations to be the more cost effective alternative? Why is it that leasing, which actually consumes more resources than does a purchase, oftentimes results in a lower discounted dollar cost than does the purchase? The simple explanation is that most lease/buy models and evaluations use a discount rate [Ref. 32: p. 12]. The discount rate is an input chosen by the decision maker and is representative of the opportunity cost over time of real resources in the private sector [Ref. 22: pp. 161-167]. The discount rate used in decision analyses is chosen by the decision maker based on the best

information available at the time. Because in most Government projects, the relevant financial or budget flows occur at approximately the same time as the resource flows, no ambiguity arises when the decision maker uses the discount rate on the financial or budget flows. However, when the resource and budget flows occur at significantly different points in time, as is the case with leasing arrangements, the use of the discount rate on actual dollar flows renders misleading results. The fact that the discounted value of the lease payments is less than the discounted dollar purchase costs, therefore, has little or no meaning. [Ref. 32: p. 12] Also, any time the discount rate exceeds the effective lease finance rate, borrowing will appear to have a negative cost and leasing will look to be the more attractive alternative [Ref. 32: p. 10].

In the author's opinion, what this means to an analysis of the Navy's lease versus buy decision model is that the model's underlying premise is exposed as unfounded and untenable. There is no circumstance, in fact, whereby a leasing arrangement is less costly to the Government than is a purchase, for the real cost to the economy measured in resources consumed is the same in both cases. Therefore, a leased MILSATCOM system represents the same dollar value as a purchased system plus the flow of dollars and resources used in arranging the lease. Table III [Ref. 32: p. 13] clearly shows that when real cost to the economy is considered, the discounted cost of the buy option will always be less than that of the lease.

TABLE III

The Real Lease versus Buy Problem

BUY	LEASE
1) Determine the flow of dollar payments in a straight buy	1) Since the lease option involves the same real resource flow as does the buy, disregard the dollar lease payments and substitute, instead, the flow of dollar payments in the buy
$BUY	$BUY
2) No additional input	2) Add the flow of resources used in arranging the lease
$BUY + ZERO = $BUY	$BUY + LEASE ARRANGEMENT
3) Calculate the present discounted value	3) Calculate the present discounted value
4) Compare and choose the lesser value	

B. FACTORS WHICH ARE NOT ADEQUATELY REPRESENTED

There are also elements of the MILSATCOM systems decision problem which, in the opinion of the author, are inadequately addressed by the Dinneen model. These issues derive, primarily, from the unique mission requirements of such systems. Although not readily quantifiable, these issues can be entered into a decision model by using such methods as a Measure of Effectiveness (MOE) criterion or Figure of Merit [Ref. 33: pp. 223-227]. However, these methods for consideration of these factors are not included in the Dinneen model whatsoever.

Because MILSATCOM systems are required not only to provide command and control to forces through communications capabilities in peacetime, but also during and after natural

disasters, national emergencies, conventional war and global nuclear war, there are certain long-term system objectives which tend never to be satisfactorily achieved. Such MILSATCOM system goals are survivability, including the robustness and redundancy of systems, and interoperability. [Ref. 21: pp. 16-17] These factors must be considered in any decision involving the acquisition of public sector satellite communications systems and the lease versus buy analysis is no exception.

1. Survivability

The issue of survivability can be separated into two distinct elements: (1) physical survivability and (2) signal survivability. According to Donald C. Latham, Deputy Under Secretary of Defense for C3I (Command, Control, Communications and Intelligence), "Today's communications systems exhibit significant shortcomings in survivability and endurance, as well as capacity, connectivity and signal covertness," [Ref. 34: p. 46].

First, physical survivability includes not only the issue of spacecraft survivability but also the survival of the ground-based, terrestrial element of the communnications system.

a. Physical Survivability of the Space-Based Element

Survivability of the spacecraft component of space-based systems requires nuclear hardening against EMP,[3] maneuverability and proliferation of spacecraft, and a

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[3]Electromagnetic pulse, EMP, is that phenomenon which occurs at the time of a nuclear burst whereby the intensity of the nuclear pulse renders electronics and electromechanical devices, especially solid-state electronics, inoperative. In the case of space-based systems, EMP bursts become a tactic used to incapacitate the enemy's command and control systems. [Ref. 21: p. 10]

shootback capability, i.e. the ability of a spacecraft to defend itself against attack. [Ref. 16: p. 10]

The immediate concern in the area of spacecraft survivability is development of nuclear hardened integrated circuits, memories, and processors needed to obviate the effects of EMP. According to studies conducted in the 1970s, integrated circuits are a billion times more likely to be destroyed by EMP than are vacuum tubes. [Ref. 34: p. 53] Although systems are more and more being hardened against EMP, nuclear hardening to satisfy the requirements set forth by the Joint Chiefs of Staff (JCS) greatly increases system costs and weight and concomitantly decreases system capacity. It is estimated that a full ten percent of base satellite system cost is required to provide JCS standards of nuclear hardening. [Ref. 16: p. 11]

In addition, maneuverability and shootback must also be sought as the Soviet Union has successfully demonstrated its ability to rendezvous and kill target satellites with its anti-satellite (ASAT) [Ref. 16: p. 11]. To counter this known threat, future satellites must either hold the capability to maneuver rapidly enough to avoid the path of the ASAT (maneuverability) or be able to defend themselves against such an attack (shootback) [Ref. 16: p. 11].

b. Ground Component Physical Security

Besides the spacecraft survivability question, there is the additional requirement for physical security of the terrestrial component of MILSATCOM systems. In fact, it may well be in the ground component that the greatest vulnerability to physical security exists [Ref. 35: p. 24]. An extensive ground-based network is required to provide the following support functions to the space-based system [Ref. 35: p. 23] :

1. Detecting, isolating and correcting, to some extent, satellite faults. Engineers on the ground analyze the fault indications received from the satellite and determine appropriate corrective commands to uplink to the satellite.
2. Performing routine maintenance functions. These functions may include anything from managing the power system to performing maneuvers.
3. Calculating satellite orbital parameters. These parameters are used to maneuver the satellite to maintain proper position and to determine satellite field of view.
4. Generating sequences of commands for real time mission performance, e.g. switching tape recorders on or moving sensors to view different areas of the earth.

Without the ground-based portion of the MILSATCOM system, the service and performance of the system soon deteriorates [Ref. 35: p. 23].

Earth terminals and Tracking, Telemetry and Control (TT&C) stations are vulnerable not only to direct, military attack but also to sabotage, natural disasters and the political whims of other countries in the case of ground stations located outside the United States [Ref. 16: pp. 10-11]. Because of the criticalness of the ground component, its control and physical security must be maintained to ensure the continued availability of MILSATCOM system services under even the most severe circumstances [Ref. 35].

c. Signal Survivability

The second element of the survivability question is signal survivability. Signal integrity is imperative to ensure a reliable and effective command and control system in all environments. The primary tactical communications

requirement is for survivable, jam-resistant systems transmitting with a low probability of interception [Ref. 36: p. 30].

Satellite repeaters offer interesting targets for jammers, however, because of the large number of signals they handle. A jamming signal can swamp the traffic signals and render a satellite useless. From a geographical point of view, the jamming of a satellite is rather easy because of the visibility of the target over a large area. There are several techniques for overcoming jamming including the use of null-steering by phased-array antennas,[4] frequency hopping[5] and time hopping.[6] [Ref. 36: p. 30] These anti-jamming techniques when incorporated into MILSATCOM systems increase the costs greatly [Ref. 16: p. 10].

2. Interoperability

Another factor to be considered in the MILSATCOM system decision problem is the requirement for interoperability and integration of systems. As an area of major concern, interoperability includes the need for compatibility not only within C2 systems of a single service, but also between services and among the systems belonging to the forces of friendly nations, as well. The goal of interoperability among systems does not always result in the achievement of the capability in the original design of a system. But it is always a goal to be allowed for in the future and,

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[4]In null-steering, the signals received by the antennas are processed dynamically and individual phase shifts are adjusted to maintain a high gain in the direction of the signal [Ref. 36: p. 30].

[5]Frequency hopping is transmission at many different frequencies per second. The hopping speed must be fast enough to avoid jamming, yet not so fast that equipment cost becomes excessive [Ref. 36: p. 30].

[6]Time hopping represents the most technically advanced means, and, therefore, most costly means of anti-jamming to date. It is a technically demanding technique which requires high-speed switching logic [Ref. 36: p. 30].

therefore, considered in the decision process. [Ref. 36: p. 30]

3. These Factors and the Lease/Buy Methodology

But what does all this have to do with the lease/buy evaluation, and what impact does it have on the Navy's lease versus buy decision model? Again, these factors which affect the MILSATCOM systems decision process center around the unique requirements which are placed on such systems. These requirements--for survivability and interoperability --are present regardless of the means of acquisition used. In most cases, these issues impact equally whether the MILSATCOM system is to be leased or bought, but they must, nonetheless, be taken into consideration during the decision process. Additionally, there is one such aspect which, in the author's opinion, calls into question the desirability of leasing as a financing mechanism for MILSATCOM systems acquisition. The survivability question of the ground-based segment is the problem area.

The vulnerabilities to earth terminals and Tracking, Telemetry and Control (TT&C) stations are the same under both the lease and the buy scenarios. However, the degree of control over such key variables as manning and staffing, the geographic location of sites and the maintenance for the ground-based elements has been much greater with the buy option in the past. With the lease option, there are serious legal questions as to whether contracts which require civilians to work in hostile or potentially hostile situations are, in fact, enforceable. So, the question of whether adequate manning will be available during those times when continued connectivity becomes most crucial are increased with the lease option. [Ref. 16: pp. 19-20] Likewise, the geographic location of ground terminals and TT&C sites is critical to the provision of MILSATCOM

services. The location of such sites away from highly populated areas is preferred and achieving mobile TT&C capabilities is especially desirable [Ref. 35: p. 25].

In the author's opinion, because the lease option which is addressed in the Navy's lease/buy decision model tends to lessen the control the military services have over these critical support elements, it is less attractive as an economic mechanism in acquiring MILSATCOM system services. However, part of the problem rests with how the Navy's model narrowly defines "lease" and "buy."

C. COMPARING APPLES AND ORANGES

A major shortcoming of the Dinneen model, in the author's opinion, is the narrow definition it assigns to "lease" and "buy" as financing instruments. At the foundation of the model, leasing is considered to be a financing mechanism which fixes performance specifications at the time of contract and then gives the lessor technical and managerial control of system development and production. Buying, on the other hand, is assumed to be a financing mechanism which is based, primarily, on design specifications, which is ripe for PPBS bickering and cutting, and which is proned to design changes throughout its development and production due to DOD managerial and technical control. In other words, the Navy's model is comparing two distinctly different products--the proverbial apples and oranges--and treating them as if they were the same.

What the model does is compare the lease of a MILSATCOM system where all inputs and variables are fixed versus the purchase of a MILSATCOM system where all inputs and variables are changing or potentially changing. In such a construction, the latter will almost always look the more costly. But the truth of the matter is, the formulation of

the decision problem within the model is faulty. Instead of a comparison between "Lease A" and "Buy A," the Navy's model compares "Lease A" with "Buy B." The results, in the author's opinion, will always be questionable.

In short, one of the model's underlying postulates is again considered deficient and misleading. There is, in fact, a whole gamut of choices on the "continuum" between a simple buy and a simple lease. Neither alternative has results that cannot be achieved through the other alternative given a willingness to absorb additional costs or sacrifice some control. The model's failure to recognize the variability of choices between different leasing and different buying mechanisms results in its own ineffectual output.

VI. CONCLUSIONS AND RECOMMENDATIONS

It is the author's contention that the Navy's lease versus buy model for MILSATCOM system decision problems is incomplete and deficient because:

1. It mistakenly assumes that public sector leasing behavior can be extrapolated directly from private sector behavior;
2. It does not adequately represent certain factors in the MILSATCOM system acquisition process such as questions of survivability;
3. It compares two distinctly different products yet treats them as identical; and
4. The model's fundamental presumption that there are situations in which leasing is more cost effective than buying is unfounded when the total cost to the Government is the measure.

For these reasons, the model should no longer be used by the Navy in assessing its lease/buy MILSATCOM system decisions.

A. LEASING AS THE "BETTER" OPTION REFUTED

As discussed in Chapter III, a 1983 GAO report cited four factors which GAO found to be significant in the continued attractiveness of capital leasing to Federal agencies [Ref. 25: Appendix I, p. 1].

1. The costs of a project can be spread evenly over a period of years by use of a leasing instrument.
2. The obligations incurred in a lease represent working capital funds, or O&M funds, instead of procurement funds.

3. The amount of scrutiny from Congress given to purchases was much greater than that given to leasing arrangements, and
4. Leasing almost always appears less costly because part of the total cost shifts from the agency's budget to the Treasury in the form of reduced tax revenues.

However, the author takes exception to each of these points. First, although spreading costs equally over a period of years appears useful and desirable for the Navy, its consideration serves to muddle the lease/buy decision because whether funds are spent one way or another has nothing to do with the actual lease versus buy evaluation. There is a tendency in lease/buy analyses to "mix apples with oranges," to compare a "fixed everything" financing mechanism (the lease) with a "variable everything" financing mechanism (the buy) and to entertain factors during this comparison which have nothing to do with the lease and buy options. A factor such as the timing of budget outlays falls into this category. Although the Agency will always be concerned with such an issue, its consideration should be kept separate and distinct from the cost effectiveness question of leasing versus buying instruments. The decision problem must be structured in terms of its impact on the whole of the economy with peculiarities of the political and bureaucratic system such as the timing of budget outlays given secondary consideration.

Second, the O&M funds versus procurement funds controversy is a similar such argument in that the issue is outside the context of the lease versus buy evaluation. Again, for the Navy, the outlay of O&M funds may well be preferable, but such a preference has little meaning when considered from the perspective of the whole economy. Whether the outlays are O&M or procurement funds, or even

some other "color" monies, does not alter the fact that they are expenditures by the Government. The cost to the whole economy and to the Government is the same in any case.

Third, the amount of scrutiny given to leasing arrangements by Congress has increased dramatically since the GAO report and especially since the Navy's controversial leasing of cargo and tanker ships [Ref. 6: pp. 32-34]. In the author's opinion, capital leasing by the DOD will no longer go unnoticed by Congress, and, in fact, there have already been initiatives to ensure Congress is appraised of DOD leasing arrangements [Ref. 6: p. 156].

Last, and as discussed previously, the lease/buy decision problem should be made with total cost to the economy as the measure of cost effectiveness. Again, this is part of the problem of keeping the lease/buy evaluation process "pure." The tendency is to adulterate the analysis with issues which result from the political and bureaucratic workings of the Federal Government--various Federal agencies, each acting to keep its own costs low even at the expense of other like agencies; different "pots" of money which affect agencies differently; Congressional areas of interest which receive special attention, either of a positive or a negative sort; the vagaries and machinations of the PPBS process; and the continuous defining and redefining of program priorities within the President's budget, within Congress, within the DOD, and within the Navy. These issues obfuscate the central question of whether a leasing arrangement or a buying arrangement is the more cost effective means of procuring MILSATCOM systems. Therefore, even though the lease may appear less costly from the Agency perspective, the ultimate choice must be based on <u>total cost</u> to the economy, and not on the more narrow desires of the Agency.

B. THE BUY--AT PRESENT AN INCENTIVE TO CHANGE

Another conclusion to which the author has come is that the present conception of the buy provides, in fact, an incentive scheme for change within DOD MILSATCOM systems. Because the buy is touted over the lease as the alternative which provides greater flexibility and control during the developmental and production phases, the underlying assumption is that changes are not only desirable but are, in fact, expected. Such a definition of the buy option goes beyond a mere capability for making changes and, actually, provides an incentive for change. Basing a MILSATCOM system buy on design rather than performance specifications goes a long way in furthering this incentive to change, as well. The restrictive lease arrangement which is based on performance specifications and fixes those specifications at the time of contract negotiation forces cost consciousness about changes. The same result could be achieved through a buy if the buy were likewise predicated on performance rather than design specifications and the specifications were fixed to the time of contract award. Again, the buy alternative, which is the preferred acquisition alternative because it represents greater cost efficiency to the economy as a whole, can incorporate some of the provisions usually used in a leasing instrument and achieve the same end result.

C. LEASE VERSUS NO CAPABILITY

Despite the foregoing major conclusions, however, there are certain circumstances under which leasing is a viable means for acquiring MILSATCOM services. Such circumstances are those in which the analysis becomes lease versus "have no capability" rather than lease versus buy. Such was the case with the GAPFILLER system. In that instance, due to the failure of the TACSAT I, the Navy was faced with the

options of leasing a commercial satellite system already operational or go without satellite supported tactical communications services for several years while a TACSAT replacement could be built and deployed. Under the circumstances, leasing GAPFILLER from COMSAT General was the preferred solution.

D. RECOMMENDATIONS

The purpose of this thesis has been to analyze the Navy's current MILSATCOM system lease versus buy decision model, the Dinneen model, and determine its effectiveness in thoroughly evaluating the lease/buy question. The conclusions generated by this analysis lead to several recommendations.

First, because the Dinneen model is formulated on faulty assumptions that leasing can be a less costly financing instrument than buying and makes the comparison between lease and buy based on two distinctly different products, the model produces misleading results. Therefore, it is recommended that the Navy discontinue its use of the model in assessing its lease versus buy MILSATCOM system decisions.

It is further recommended that, in future lease/buy analyses, the Navy consider <u>total costs</u> to the economy. The Navy should fully recognize that there is no circumstance in which the total costs of leasing to the whole economy and Government will be less costly than buying. Also, every attempt should be made to keep the analysis "pure" from considerations outside the strict cost comparison of leasing a particular system and buying that same exact system. By keeping the analysis unmuddled and "pure," additional choices become available. For instance, in an effort to determine the <u>true</u> costs of change, it may be desirable for

the Navy to lease a MILSATCOM system with the option to make changes written into the contract. Such a scheme would allow decision makers to consider changes based not only on the resulting additional system capability but also on the resulting additional cost. The cost of change would be readily measurable under such an incentive scheme, and this information would be useful in ascertaining whether the option to change is truly worth its price tag.

Last, it is recommended that future MILSATCOM system acquisitions be based on performance rather than design specifications in order to achieve the greatest amount of efficiency for the dollars spent. Design specifications create an unstated but real incentive to change and the true costs of such changes are often unclear. With performance specifications, on the other hand, there is no similar incentive for change and the system manufacturer is able to maximize efficiency in achieving the stated performance level.

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